Telecommunication Switching Technology - 3 ov

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Information:
http://www.tct.hut.fi/opetus/s38110/...

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Contents and goal of the course

- ✔ **Introduction**
- ✔ **Switching matrixes**
  - ° **Synchronisation networks**
- ✔ **Reliability, fault-tolerance,**
- ✔ **Signaling, fundamentals**
- ✔ **Signaling, continuation**

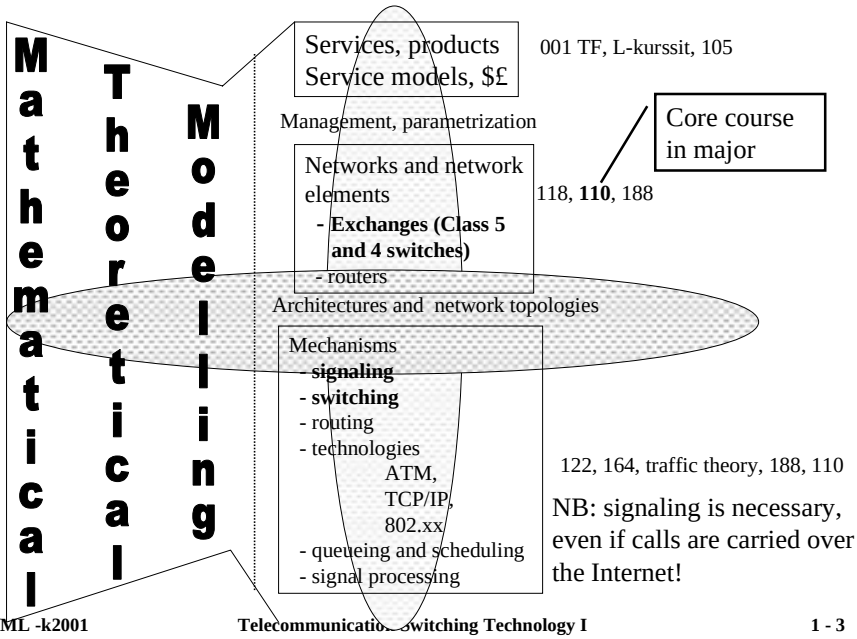
Signaling will be analysed on a functional level. Focus is on understanding advantages and drawbacks of widespread solutions

Goal of the course: To understand the basic structure and basic function of a Switching System.

--> to understand how a switching system works, what does it do and why is it as it is.

--> to understand the technology trend in switching

Networking technology studies on 38.xxx courses



Course Requirements

- ✔ **J. Y. Hui, Chapters 1 - 5**
- ✔ **Freeman, chapters as on the www-page**
- ✔ **LME study package on signaling - exercise hours**
- ✔ **These lecture notes**
- ✔ **Lectures (and these Notes) are the best source for: + Voip, TCAP, SCCP, MTP, V5, MAP ...**
- ✔ **Compulsory Calculus/exercises**
- ✔ **Grading**
  - **Calculus max + 3 …+6 points**
  - **No calculus => No admittance to Examination!!**
  - **Examination 30 points**

Telecommunication networks - Introduction

- ✔ **Types of telecom networks**
- ✔ **Equipment types in telecom networks**
- ✔ **Hierarchy in telecom networks**
- ✔ **Switching Systems**

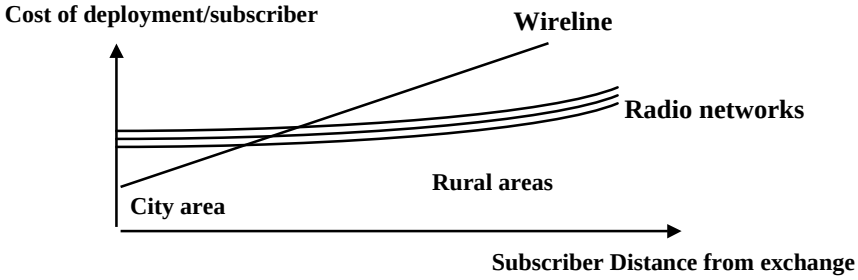
Communication networks can be divided into

- ✔ **Switched Telephone Networks (PSTN, ISDN, GSM …)**
- ✔ **Computer (data) networks (x.25, Internet)**
- ✔ **Specialized or Professional Networks (PMR, Tetra …)**
  - ° **PMR - professional mobile radio**
- ✔ **This course concentrates on telephony networks. In addition we will touch data networks in the area of packet switching**

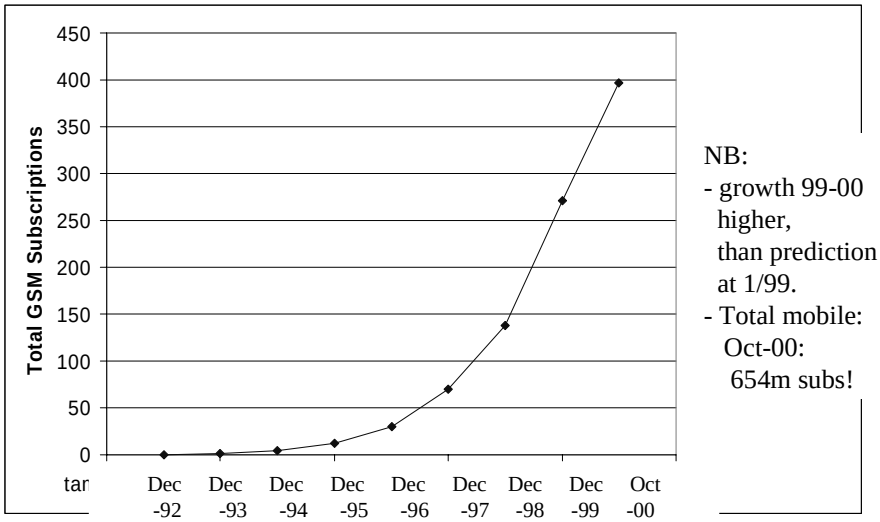
Exchanges or Switching Systems are used in
Public Switched Telephone Networks,
Integrated Services Digital Networks,
Cellular Networks and
Specialized Networks

Telephone Networks

- ✔ **Telephone networks can be divided into:**
  - **Fixed Networks (wireline networks)**
  - **Mobile networks (cellular networks)**
  - **A wireless network can be either fixed or mobile**
- ✔ **Growth of subscriber base takes place in cellular networks. In Fixed networks we see only limited new deployment while total nrof subscriptions is declining.**



World GSM subscriptions (millions)

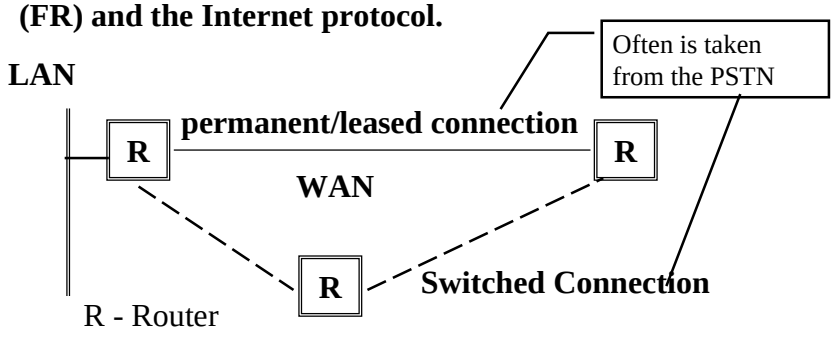


NB:
- growth 99-00 higher, than prediction at 1/99.
- Total mobile: Oct-00: 654m subs!

Source: GSM Association

Computer (data) networks

- ✔ **A data network is any type of overlay network built for data traffic.**
- ✔ **Data networks are built using both permanent and switched connections.**
- ✔ **Protocols in Data Networks include X.25 ja Frame Relay (FR) and the Internet protocol.**



Specialized networks

- ✔ **Specialized (professional) networks include:**
  - **Military networks**
  - **Emergency services networks**
  - **Police networks**
  - **Company / Utilities communication networks (Railways, Gas and Electricity companies)**
- ✔ **Widely varied technologies are used, some networks are overlay networks making use of PSTN resources, some are built using dedicated resources only.**
- ✔ **In Finland digital VIRVE, based on TETRA standard, is being built.**
- ✔ **Many types of (trunking) analogue radio networks exist (PMR - professional mobile radio).**

Equipment types in telecommunication networks

- ✔ **Based on usage type, the equipment can be categorized into:**
  - **Terminal equipment or CPE - customer premises equipment**
  - **Exchanges (Switching Systems, Central Office in US)**
  - **Network Service Nodes**
  - **Cross-connect Equipment**
  - **Transmission Systems**

In terms of end- to-end service Cross-Connect and transmission equipment work on OSI layers 1 and 2. Nevertheless, they contain (management) software which can be on any OSI layer.

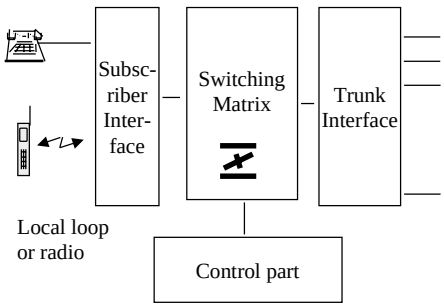
Key issues on each layer in the telecom network include

OSI			
7	Service Nodes	Intelligent Network Nodes, Voice Mail, ...	• Differentiation, fast service creation and deployment, new service architectures • Interoperability, billing
3	**Switching Systems**	***Exchanges, Concentrators, PBXs***	• Network design and dimensioning, routing/routeing, • **interworking (signaling),** charging, **mobility** • **circuit and packet switching**
2	Transmission Systems	PDH, SDH, WDM, xDSL, BSS/GSM, Radio links, Cross-connects ...	• Coverage, large capacity (multiplexing), • Efficient use of radio band, radio network planning
1	Circuit connections	Copper cable, cox, fiber, radio path, ...	• Right of way, long life cycle, more efficient use of existing plant, • competition in the local loop/natural monopoly

Terminal Equipment

- ✔ **Terminal Equipment are owned and managed by the subscriber. They are used to communicate with another similar device across the network or with a Service Node in the network.**
- ✔ **Examples of terminal equipment types:**
  - **Phones, mobile phones**
  - **Private (Automatic) Branch Exchange (PBX or PABX)**
  - **Modems**
  - **Router, bridge, LAN-switch, hub**
  - **Telemetric equipment**
- ✔ **A key assumption from the network point of view is whether TEs are Intelligent or not! This has a big impact on the choice of solutions on the switching layer in the network.**

Exchanges implement switched services



Software systems in the Control part:
- signaling and call control
- charging and statistics
- maintenance software

- ✔ **Carriers of network intelligence.**
- ✔ **Routeing of calls.**
- ✔ **Responsible for service level (grade of service)**
- ✔ **Giants of processor capacity and software ~ computers with many external connections and a lot of real-time parallel activity.**

Service Nodes are computers connected to the edge of the telecom network

- ✔ **Intelligent Network SCP - Service Control Point**
- ✔ **Voice mail systems**
- ✔ **Intelligent announcement device (intelligent peripheral or SRP - special resource point)**
- ✔ **Voice response system**

By using Service Nodes operators aim to differentiate their service and thus compete not only on price.
Operators are looking for implementations that are switching system independent and have open software environment.
Service Nodes may also control the set-up of calls.

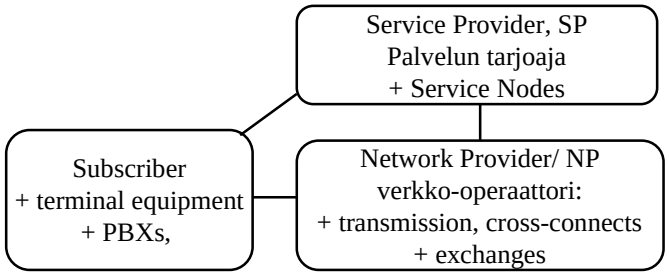
The purpose of Digital Cross-Connects is rearrangement of circuit connections

- ✔ **Work on OSI Layer 1 in the end-to-end view.**
- ✔ **Use cases: management of leased circuits, grooming of PCM -connections (from partially filled PCMs to fully filled PCMs).**
- ✔ **A Digital Cross-Connect has a switching matrix and a light-weight control part that implements commands issued by a management system.**
- ✔ **The network management system is responsible for managing end-to-end circuit connections. The network management system issues commands to the cross connects to set up and tear down connections. The Cross connect may try to recover existing connections also in case of partial failures.**

Transmission systems are used to optimize the use of physical circuits and to build coverage

- ✔ **Carry large bit streams across any distances.**
- ✔ **Are on OSI layer 1 in end-to-end view.**
- ✔ **Use optical or electronic components.**
- ✔ **E.g. PDH-systems ja SDH -systems**
- ✔ **An SDH-system needs more than one million source lines of software code ==> is a software product!**
- ✔ **Exchanges and transmission systems need to be compatible: they need a common specification on what does a *bit* and a *frame* look like on a circuit connection. They need a common understanding on *time (bit time, frame time)*.**

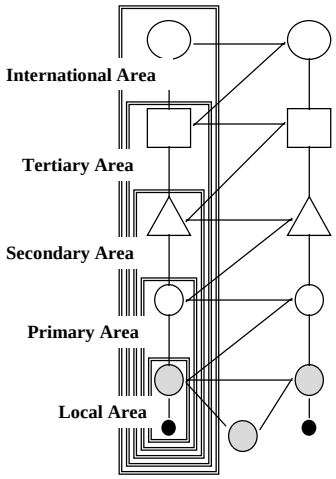
In business terms Communication Services can be broken down to Roles and Stakeholders



- This course analyses *signaling* which is the language used on the interfaces in the above figure.
- We will show that the real world signaling systems do not ideally match this business model.
- This has a significant impact on business boundaries: although NP business is considered dull and boring, NP is still the king! - I hope you will be able to argue on these matters after this course!

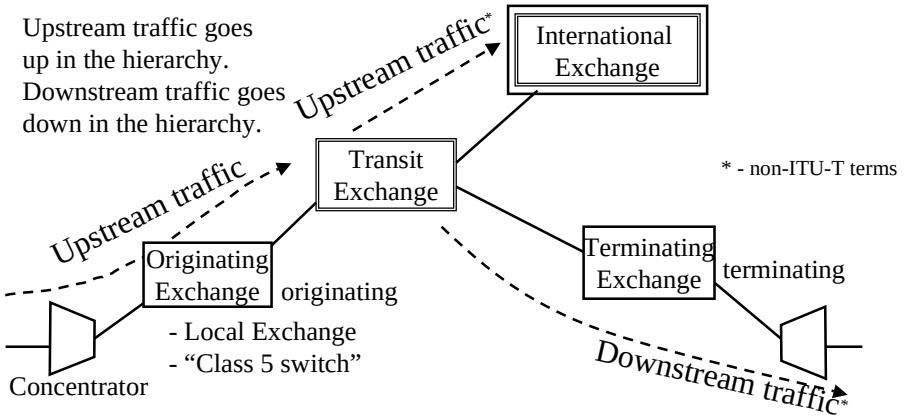
Telecommunication network hierarchy

- ✔ **ITU-T has specified a world wide hierarchy for the telecom network.**
- ✔ **An end-to-end connection can have max 12 circuit connections out of which 4 can be international.**
- ✔ **Exchange types**
  - **local exchange (Class 5 Switch in US)**
  - **originating/terminating exchange**
  - **transit exchange**
  - **long distance exchange**
  - **international exchange**
- ✔ **Traffic categories in exchanges**
  - **upstream, downstream**
  - **incoming, outgoing, internal, terminating, originating, transit**



Categories of traffic and exchanges

Upstream traffic goes up in the hierarchy. Downstream traffic goes down in the hierarchy.



* - non-ITU-T terms

In Addition: *outgoing* traffic , incoming traffic (from the point of view of an exchange
Internal traffic: from one subscriber connection to another in a local exchange,
terminating traffic: traffic that is terminated to subscribers at a terminating exchange,
transit traffic = from one network connection to another.

ITU-T specifies switching:

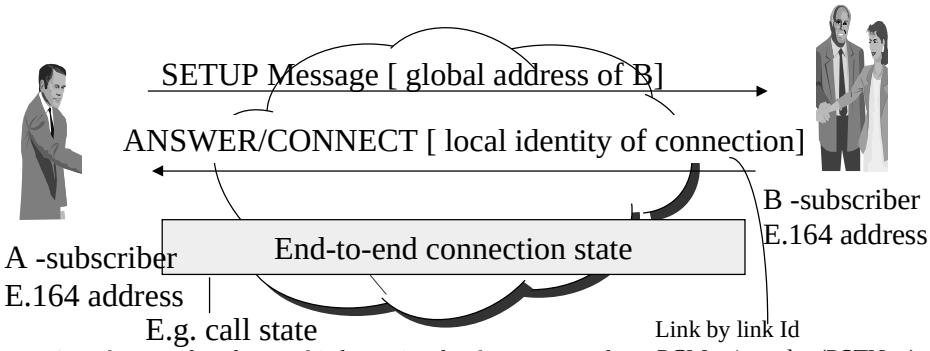
The establishing, on-demand, of an individual connection from a desired inlet to a desired outlet within a set of inlets and outlets for as long as is required for the transfer of information ***(ITU- T terms and definitions).***

In this definition inlet = a line or a channel

Service Paradigm in a Circuit Switched Network

- ✔ **A permanent capacity circuit is set up on demand and sold to the customer. The networks guarantees the quality of the circuit.**
- ✔ **The customer can use the transfer capacity as best he/she can or as poorly as he/she can.**
- ✔ **The customer pays based on used network resources (usage based charging).**

In the Connection Oriented Model connections are set up, and in the process the network translates global addresses to local



In PSTN the transfer of control information for the purpose of setting up, tearing down and maintaining of calls is called signalling (UK) or signaling (US).

Link by link Id
- PCM+ time-slot (PSTN…)
- logical channel (x.25)
- ...

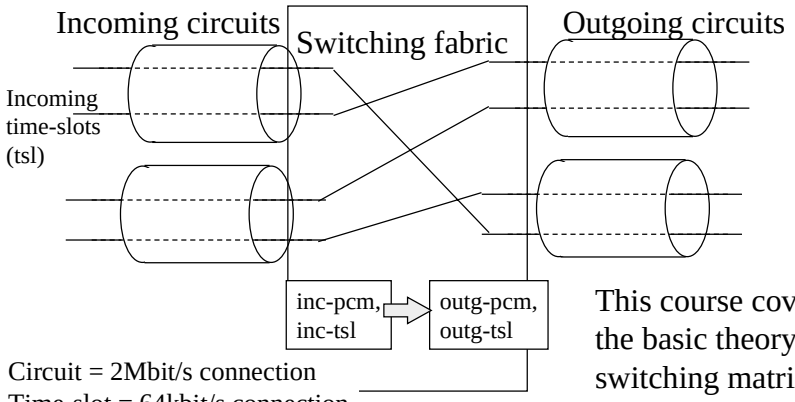
Without switching, a physical connection is need from every user to every other user.

Connections can be set up also using network management commands

- ✔ **The PSTN can be used also for providing leased connections**
- ✔ **An alternative technology for leased connections e.g. for LAN-interconnection is Frame Relay which transfers variable length frames or packets. A frame carries a local address.**
- ✔ **Also ATM - Asynchronous Transfer Mode can be used for setting up semi-permanent virtual connections**

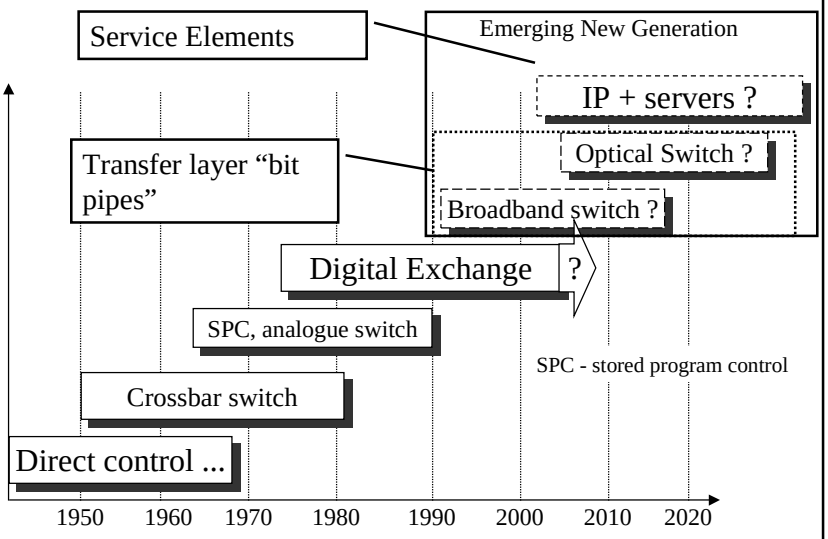
In this model, network nodes do not need support any form of signaling.

Switching matrix maps the bit stream from an incoming PCM+tsl to an outgoing PCM+tsl and thus establishes the call path

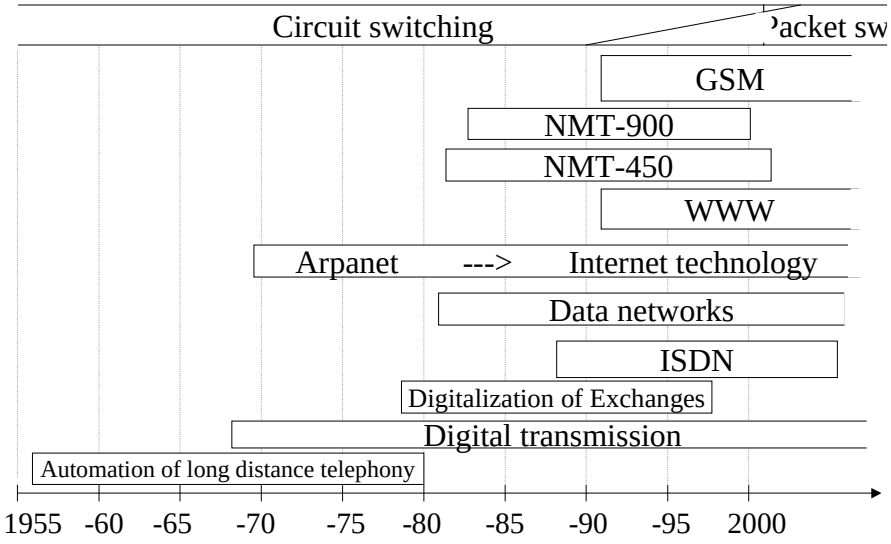


This course covers the basic theory of switching matrix design and structure.

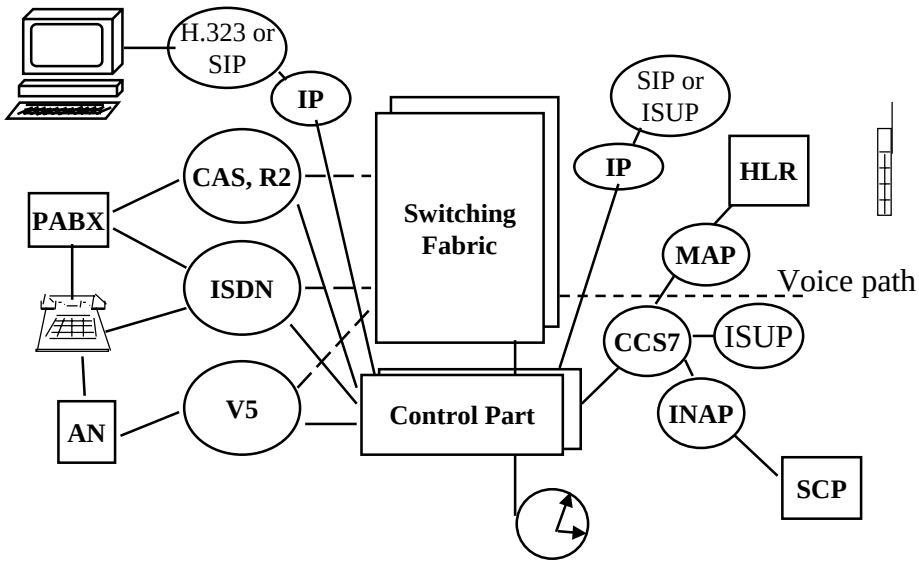
Life cycles of Product Generations



Road map of Networking technology in Finland



Summary of course scope



Impact of IP Voice and IP Telephony

- ✔ **New signaling systems are needed but most of ISDN signaling properties will be reused or inherited**
- ✔ **Exchanges turn into "Call Processing Servers". These will not have a switching fabric for voice signals**
- ✔ **The Switching Fabric is replaced by the router network**
  - ° **In Giga- and Terabit routers a packet switching fabric is needed**
- ✔ **Control plane and the transport plane will be clearly separated:**
  - ° **calls are first set up as logical sessions and only when it is known that the parties involved can and wish to communicate the transfer of voice packets starts.**
  - ° **Voice packets and signaling typically take quite different paths.**